

Report on Supervision of Tests and Evaluation of a System for Market Coupling operated by EMCC

Scientific Study on Behalf of European Market Coupling Company GmbH Conducted by Forschungsgemeinschaft für Elektrische Anlagen und Stromwirtschaft e. V. and the Institute of Power Systems and Power Economics (IAEW) of RWTH Aachen University

Introduction

The European Market Coupling Company (EMCC) has been assigned to establish and operate a market coupling at the German / Danish border in order to replace the present explicit auction related to the market areas of Germany and Denmark-West and the implicit auction of the Kontek DC-link conducted by Nord Pool Spot (NPS). It is intended that EMCC's market coupling will increase efficiency¹ and social welfare at the German / Danish border. EMCC started operation of the market coupling in 2008 but experienced major problems. As a result EMCC temporarily suspended operation of the market coupling in order to analyse experienced problems and to adjust design and implementation of the market coupling. A consortium of Forschungsgemeinschaft für Elektrische Anlagen und Stromwirtschaft e. V. (FGH) and the Institute of Power Systems and Power Economics (IAEW) of RWTH Aachen University has been asked to supervise and evaluate tests performed on the amended market coupling system. This report documents the main findings of this supervision task.

For the purpose of performing a market coupling EMCC had to set up a market coupling design, which fulfils all technical, legal and organisational constraints. Finally, EMCC had to develop an IT-system to solve the underlying optimisation task as mentioned above. Besides technical constraints, which are common for market coupling tasks, such as observing available transfer capacities (ATC), EMCC had to consider further boundary conditions in the setup of the market coupling design. These comprise, inter alia, requirements on plausibility of the market results, i.e. avoiding adverse flows and suboptimal utilisation of interconnectors. Ideally this can be achieved by implementing a price market coupling, in which in addition to energy transfers also market prices are determined by the system-wide optimisation and consequently used by participating power exchanges. EMCC is initially restricted to a volume market coupling, in which only transferred volumes of energy are determined in the system-wide optimisation and prices are determined by the participating power exchanges EEX and NPS.

As a consequence of volume market coupling, market results cannot completely comply with named requirements on the plausibility of market results in all cases. Deviations from the optimal solution occur even though involved system, i.e. in this case EMCC's IT-system and the systems of the power exchanges, deliver optimal results when evaluated individually. Such deviations are mainly caused by the fact that in the system-wide optimisation a "global view" is obtained, as the whole system

¹ The implicit auction of the Kontek DC-link has potential for an increase of efficiency with respect to the price signal provided in this auction, since the KONTEK market area price for Germany is in general not in line with the more reliable price signal, derived from the liquid spot market at EEX. The results of the implicit auction of the Kontek DC-link are – viewed individually – optimal and plausible within the limited scope of the optimisation performed by NPS.

under consideration is optimised at once, whereas in the subsequent optimisation performed by the participating power exchanges only a limited “local view” on the individual market areas is given. Discrepancies occur e.g. in block selection and may result in price deviations possibly causing adverse flows. Further, deviations are partially caused by a lack of sufficient harmonisation of rules at participating power exchanges. Therefore, EMCC’s task is to design and implement a volume market coupling, which provides results with only small violations of named requirements but improves efficiency compared to the status-quo.

Improvement of Market Coupling System

During the first ten of days of operation in 2008 in particular adverse flows of high magnitude occurred and hence EMCC decided to suspend operation in order to analyse experienced problems and to improve the system’s performance. In a first phase, in particular improvements regarding a more detailed modelling of the participating power exchange’s price determination and block selection rules were achieved. However, tests of the improved system still provided unsatisfying results in particular due to the difficulties concerning local view / global view.

Therefore, in a second phase EMCC adjusted the design of the market coupling in such a way that besides binding information on energy transfers between the coupled market areas also an indicative price signal and synthetic elasticity for the German market area is provided by EMCC for price calculation at NPS. This adjusted design allows in the way it is constructed for minor imbalances with respect to volumes imported to the German market area vs. volumes exported from both Danish market areas (and vice versa).

Test Procedures

EMCC thoroughly tested this improved market coupling design and its implementation. In detail, EMCC tested a total of 80 historic trading days, under which there were the ten days of operation in 2008, a period of 34 consecutive days as well as days with negative prices at European Energy Exchange (EEX) and EPEX respectively. Tests have been performed under a realistic simulation environment, i.e. original order books and ATC values were provided by power exchanges and transmission system operators and participating power exchanges performed an individual market clearing subsequent to EMCC’s market coupling. EMCC has implemented a systematic testing procedure, which includes a detailed analysis of test results indicating adverse flows. In particular participating power exchanges as well as Deutsche Börse Systems AG (DBS), as provider of EMCC’s IT-System, took part in these analyses.

Test Results

After completion of tests, detailed results have been made available to FGH/IAEW for the purpose of evaluating the improved system’s performance. In summary, tests show a major improvement of the system’s performance compared to the status of first operation in 2008. Further, tests indicate that compared to currently applied congestion management methods at the German / Danish border, EMCC’s market coupling can significantly increase the economic efficiency of the allocation of available cross-border capacity. However, tests also show that there still is a chance for the occurrence of adverse flows and suboptimal utilisation.

Table 1 shows the occurrence of hours with adverse flows² on the interconnections between Germany and Denmark. Of the 1920 hours a total of 406 hours on the interconnection Germany / Denmark-West and 182 hours on the connector Germany / Denmark-East show adverse flows. But it has to be

² Hours are considered to have an adverse flow in case the flow, calculated by EMCC’s systems, is directed from a high to a low price area, when considering prices determined by the power exchanges.

pointed out that only 60 hours with adverse flows on the interconnection Germany / Denmark-West induced a negative congestion rent³ of more than 100 Euro. Each of the adverse flows on the interconnection Germany / Denmark-East induce a negative congestion rent of less than 255 EUR. Only in seven hours adverse flows with a negative congestion rent of more than 1,000 EUR, the highest of which amounting to approx. 4,800 EUR, occurred.

	Germany/Denmark-West	Germany/Denmark-East
Total Nr. of hours	1920	1920
AF with neg. CR \leq 100 Euro	346 (18.0 %)	168 (8.8 %)
AF with 100 Euro < neg. CR \leq 1000 Euro	53 (2.8 %)	9 (0.5 %)
AF with neg. CR > 1000 Euro	7 (0.4 %)	0
Max. neg. CR	4796 Euro	255 Euro

Table 1: Hours with adverse flows (AF), i. e. negative congestion rent (neg. CR)

As Table 2 shows, tests reveal also suboptimal utilisation. This occurs in 952 of the hours for the border Germany / Denmark-West and in 468 of the hours for the border Germany / Denmark-East in case all instances with price differences despite uncongested interconnectors are considered. In such hours with suboptimal utilisation the average price delta between adjacent market areas is with 0.47 EUR/MWh on the interconnection Germany / Denmark-West and with 0.91 Euro/MWh on the interconnection Germany / Denmark-East comparably low. The involved test participants, i.e. EMCC, involved power exchanges and involved TSOs, defined that only instances with a price difference of more than 0.20 Euro/MWh and unused capacity are considered as suboptimal utilisation. Based on this definition, 165 of the hours show suboptimal utilisation on the interconnection Germany / Denmark-West and 127 on the interconnection Germany / Denmark-East respectively.

	Germany/Denmark-West	Germany/Denmark-East
Total Nr. of hours	1920	1920
Suboptimal with Δ price \leq 0.10 Euro	722 (37.6 %)	304 (15.8 %)
Suboptimal with 0.10 < Δ price \leq 0.20 Euro	65 (3.4 %)	37 (1.9 %)
Suboptimal with 0.20 < Δ price \leq 0.50 Euro	71 (3.7 %)	30 (1.6 %)
Suboptimal with 0.50 < Δ price \leq 1.00 Euro	31 (1.6 %)	18 (0.9 %)
Suboptimal with 1.00 < Δ price \leq 10.00 Euro	51 (2.7 %)	73 (3.8 %)
Suboptimal with Δ price > 10.00 Euro	12 (0.6 %)	6 (0.3 %)
Average Δ price in suboptimal hours	0.47 Euro	0.91 Euro

Table 2: Hours with suboptimal utilisation

Further, the adjusted volume market design may yield imbalances as described above. These imbalances are within a predefined tolerance, which has been set to +/- 1 MWh per hour throughout the tests. For reasons of rounding these imbalances may increase to +/- 1.1 MWh.

Exemplary Comparison with currently applied Congestion Management Methods

In comparison, in the period of the tested 34 consecutive days (29/12/2008 – 31/01/2009) in the explicit auction between Germany and Denmark-West adverse flows⁴ occurred in 252 out of all 816

³ Congestion rent is calculated as the product the energy flow and the price difference between the relevant price areas.

⁴ This analysis is based on the capacity sold and price paid in the day-ahead explicit auction. Capacity sold from market area A to market area B is considered an adverse flow in case that after clearing at power exchanges the price in market area A turns out to be higher than in market area B. In this case the magnitude is calculated by multiplying the amount of capacity sold and the price paid in the explicit auction. Data from www.energinet.dk

hours (approx. 31 %), with an average magnitude of 2,250 EUR, under which the highest had a magnitude of approx. 24,000 EUR. When considering prices for Germany set by EEX and prices for Denmark-East set by NPS, for the DC-link between Germany and Denmark-East, adverse flows occurred under the current congestion management method in 135 of all 816 hours (approx. 17 %) with an average magnitude of 1,350 EUR, under which the highest adverse flow had a magnitude of 7,200 EUR⁵.

Additional Remarks and Recommendations on Test Results

Even though the implemented algorithm cannot systematically restrain occurrence or magnitude of adverse flows, as these are inherent to a volume market coupling, the performed tests give robust empirical evidence of a very low likelihood for the occurrence of adverse flows of higher magnitudes. FGH/IAEW identified several possible reasons for the occurrence of adverse flows:

- Local view / global view problem relating to the German market area, i.e. in case of vertical overlaps in the German market area, the EEX system may choose a “wrong” price since it has no price information for the Danish market areas: it is pointed out that FGH/IAEW assume that the EEX system can at this point not easily be extended to process such price information. The effect of such an extension on number and magnitude of adverse flows is expected to be low since for the German market area the range of vertical overlaps is in general comparably small. Hence, FGH/IAEW do not consider such an extension reasonable.
- Differences in block selection due to local / global view problem: such differences are considered part of the volume market coupling inherent sources for adverse flows, which cannot systematically be eliminated unless market participants agree to establish a price market coupling.
- Negative prices at EEX / non-harmonised price caps: In particular the likely negative prices in the German market area may lead to adverse flows of higher magnitudes (up to the absolute value of the negative market prices multiplied with the ATC value). Currently the risk of negative prices appears manageable. Therefore it seems sufficient to not consider bids/offers within the negative price range until also NPS has implemented a negative price cap, which is assumed to be done at short-notice. However non-harmonised price caps will remain. At present the probability of higher negative prices than the future negative price cap of NPS is very small. But in future this could be a problem.
- The NPS system awaits prices with a precision of one decimal place. Analyses of test results indicate that in particular rounding issues lead to a high number of adverse flows of smaller magnitude. EMCC has already implemented an “intelligent” rounding within the test phase, which reduces adverse flows significantly but does not completely avoid them. Further improvements could be achieved by configuring NPS system in such a way that its EMCC-interface receives indicative prices and synthetic elasticity for the German market area with two decimal places.
- Currency conversion of all non-EURO orders in NPS market areas to EURO at time of calculation: minor adverse flows may occur due to non-harmonised currency conversion rates for the EMCC and the NPS calculation. FGH/IAEW assume the effect to be comparable to rounding problems.

Conclusions

The FGH/IAEW consortium regards the amended market coupling system of EMCC as a major improvement of the currently applied congestion management methods at the border between Germany and Denmark. It increases the efficiency of the capacity allocation at this border and leads

⁵ When considering prices from NPS for Denmark-East and Germany no adverse flows occur within the scope of the optimisation of NPS.

to a higher social welfare than the explicit auction at the border Germany/Denmark West or the Kontek market coupling system respectively. The system has been significantly advanced since the first period of operation in 2008 and the likelihood for the occurrence of adverse flows of high magnitude has been reduced to a large extent.

However, the occurrence of adverse flows cannot systemically be avoided. This could only be achieved in a price market coupling, which EMCC is initially not able to establish at the considered border in order not to affect other market coupling projects like the CWE project. In general, performed tests have proven EMCC's system to be capable of performing a price market coupling without major adjustments. As long as power exchanges participating in EMCC as well as power exchanges of other market coupling projects can not establish an overall price market coupling, further improvements of the quality of the volume market coupling could be achieved by further harmonising rules of the participating power exchanges (e.g. regarding handling of vertical overlapping curves and price caps) and by implementing the system upgrades recommended above.

Considering the increase of efficiency and social welfare for the congestion management at the German / Danish border, which can be achieved by the current status of EMCC's market coupling system, the consortium of FGH/IAEW recommends a re-start of the market coupling by EMCC. However, market participants should be aware that this market coupling may yield market results inducing adverse flows and suboptimal utilisation in some cases. Hence, this market coupling should be regarded as a helpful and sensible step towards a more global price market coupling solution.

Mannheim and Aachen, October 1, 2009

Forschungsgemeinschaft für Elektrische Anlagen und Stromwirtschaft (FGH) e.V.

Institute of Power Systems and Power Economics (IAEW) of RWTH Aachen University